

## REMARKS

Favorable reconsideration and allowance of the present application are respectfully requested in view of the amendments above and the following remarks.

### STATUS OF CLAIMS AND SUPPORT FOR AMENDMENTS

Upon entry of this amendment claims 6-27 will be pending in this application. Support for the amendments to claims 6-21 can be found in the claims as originally filed, as well as in the specification at pages 5-6. Support for new claims 22-27 can be found in the specification at pages 5-6.

### OBJECTION TO SPECIFICATION

At page 2 of the Office action dated November 18, 2008, the Examiner has objected to the specification, specifically, to the second paragraph on page 5. Applicant respectfully submits that the paragraph, as amended, is correct. Accordingly, this objection should be withdrawn.

### REJECTION UNDER 35 U.S.C. § 112, SECOND PARAGRAPH

At page 2 of the Office action, the Office has rejected claim 9 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regards as the invention. Applicant respectfully traverses this rejection for the reasons given below.

Applicant submits that claim 9 no longer contains the terminology mentioned in the Office action, and that this rejection should be withdrawn.

REJECTION UNDER 35 U.S.C. § 102

At pages 3-5 of the Office action, the Office has rejected claims 6-13 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent 6,129,779 (Bohland et al.).

Applicant respectfully traverses this rejection for the reasons given below.

Applicant respectfully submits that Bohland et al. does not anticipate claims 6-13 because it does not disclose a single embodiment of a process containing the process steps recited in Applicant's claims and arranged as recited in the claims. *See Net MoneyIN Inc. v. VeriSign Inc.*, Fed. Cir., No. 07-1565 (October 20, 2008); *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 220 USPQ 193 (Fed. Cir. 1983); *In re Arkley*, 455 F.2d 586, 172 USPQ 524 (CCPA 1972).

Nowhere does Bohland et al. disclose a process where a spent selenium filter mass is leached with a hydrogen peroxide solution, selenious acid is removed from the leaching process, and the leached filter mass is contacted with aqua regia solution, which is separated from the filter mass and from which mercury is precipitated and separated in disposable form. The disclosure of such a process would seem to be a fundamental prerequisite for concluding that Bohland et al. anticipate the claims, and yet the Office action does not even allege that such a process is disclosed in Bohland et al.

For example, instead of disclosing a process for treating spent selenium filter mass, Bohland et al. make vague references to "an article comprising a non-metallic friable substrate and a predetermined metallic material." Bohland et al., column 2, lines 35-38. Bohland et al. specify this further, stating:

Example of articles comprising at least one non-metallic friable substrate and at least a predetermined metallic material include, but are not limited to, cadmium telluride photovoltaic solar cell modules, copper indium diselenide photovoltaic solar cell modules,

cathode ray tubes, lead acid battery casings, substrates having lead paint therein, fluorescent lamps, glass mirrors and plasma flat panel displays.

Bohland et al., column 2, lines 61-67 (emphasis added). Nowhere in this quoted passage (or elsewhere in Bohland et al.) are spent selenium filter masses mentioned. Applicant is well aware that this disclosure states that the listed articles are "examples" of suitable articles; however, it is the burden of the Office to establish anticipation, and thus that Bohland discloses every element of claim 6 arranged as recited in the claim. Applicant respectfully submits that, based upon the failure of Bohland et al. to disclose spent selenium filter masses, the Office has failed to carry this burden.

As another example of the failure of Bohland et al. to disclose every element of Applicant's claims, Applicant submits that Bohland et al. disclose a number of different "predetermined metallic elements," including:

hazardous metallic materials such as, barium, cadmium, lead, mercury, selenium, and silver, and valuable metallic materials such as, tellurium and gold.

Bohland et al. column 2, lines 58-60. Bohland et al. does not disclose a particular embodiment directed to recovering mercury and/or selenium. Nothing in Bohland et al. indicates that, among the laundry list of metallic elements provided by Bohland et al., mercury and selenium are particularly important. To the contrary, the specific embodiments disclosed by Bohland et al. relate to the recovery of cadmium and tellurium ("First Embodiment"), to the recovery of silver and lead ("Second Embodiment"), and to the recovery of gold and lead ("Third Embodiment"). None of these embodiments appear to relate to, or involve, the recovery of mercury or selenium.

As yet another example of the failure of Bohland et al. to anticipate Applicant's claims, Applicant points out that nowhere does Bohland et al. teach the use of a treatment process that involves leaching with a hydrogen peroxide solution, followed by treatment with aqua regia. The first and second embodiments of Bohland et al. appear to use a single etching step to remove two "predetermined metallic elements." See Bohland et al. at column 7, lines 53-59; column 8, lines 35-45, and column 10, lines 34-37. The third embodiment uses an aqua regia treatment step to dissolve gold, but this is preceded by a concentrated nitric acid etching step, and not a step involving treatment with hydrogen peroxide. See Bohland et al. at column 11, line 40 and at column 12, lines 4-10.

In addition, the Office's inherency theory is without support in the record. For this reason as well, Bohland et al. does not anticipate Applicant's claims.

In this regard, the Office action states:

While Bohland et al. does not explicitly state that hydrogen peroxide leaches the metallic element from the non-metallic friable substrate, it would have been considered that such a process would inherently occur in the presence of hydrogen peroxide; furthermore, the formation of selenious acid should occur given that the necessary reagents are present, which is the case for Bohland et al. One skilled artisan would have predicted the substantially same result. Thus, one would have concluded the teaching of Bohland et al met the claim.

Office action dated November 18, 2008 at page 4 (emphasis added). As explained above, nowhere does Bohland et al. disclose an embodiment where "the necessary reagents" are present, i.e., an embodiment where the mercury and selenium present in spent selenium filter mass are present in the feedstock. Accordingly, it has not been shown that such elements (or the formation of selenious acid) are "necessarily present" in the process described in Bohland et al. As even the MPEP recognizes,

"[t]he fact that a certain result may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic." MPEP § 2112(IV) (emphasis in original). Applicant respectfully submit that the Office has failed to even establish that the alleged inherent result "may occur" for the reasons given above. Under these circumstances, Applicant submits that the Office has completely failed to establish sufficient inherency upon which to base an anticipation rejection.

In view of the complete failure of Bohland et al. to disclose a process containing each of the steps recited in claim 6 arranged in the order recited therein, Applicant respectfully submits that Bohland et al. does not anticipate claim 6. Since claims 7-13 depend from claim 6, these claims are not anticipated by Bohland et al. either. Accordingly, this rejection should be withdrawn.

#### REJECTION UNDER 35 U.S.C. § 103

At pages 5-6 of the Office action dated November 18, 2008, the Office has rejected claims 14-21 under 35 U.S.C. § 103(a) as being unpatentable over Bohland et al. in view of U.S. Patent 3,786,619 (Melkerson et al.). Applicant respectfully traverses this rejection for the reasons given below.

The Office action states:

Regarding claims 14-21, each claim is different from previously mentioned Bohland et al. which do not explicitly teach using selenious acid to make new selenium filters.

Melkerson et al. disclose a process of making a selenium filter from aqueous  $\text{SeO}_2$ , which is equivalent to selenious acid (column 5, lines 6-8).

It would have been obvious at the time of invention to use the selenious acid that would form from a process such as Bohland et al., the process of the instant application, or any process that produces selenious acid, to form a selenium filter mass in the manner described by Melkerson et al.

Office action dated November 18, 2008 at page 6 (emphasis added).

As Applicant has explained above, there is no disclosure in Bohland et al., either explicit or implicit, of a process that would inherently form selenious acid, Bohland et al. does not even disclose a specific embodiment of a process wherein a feedstock containing selenium is contacted with a hydrogen peroxide solution. To the contrary, Bohland et al. describe a variety of treatment solutions not all of which include hydrogen peroxide.

In addition to the reasons given above for the lack of any inherency of selenious acid formation in Bohland et al., the Office's reliance upon an inherency theory as the basis for its obviousness rejection is misplaced. There is no indication, either in Bohland et al. or from Melkerson et al., that a worker having ordinary skill in this art would recognize that selenious acid would form whenever, as the Office appears to assert, if a feedstock containing selenium were to be supplied to a process disclosed by Bohland et al. To the contrary, because Bohland et al. disclose a variety of different etching solutions, not all of which contain hydrogen peroxide, Applicant submits that one of ordinary skill in the art would recognize that the formation of selenious acid would not necessarily occur in every possible processing of selenium-containing feedstocks using a process of the type disclosed in Bohland et al.

Accordingly, Applicants respectfully submit that there would have been no reason to combine the teachings of Melkerson et al. with those of Bohland et al., that even if the teachings were combined, the claimed process would not be obtained (because of the various deficiencies of Bohland et al. noted above, and which are not cured by, or alleged by the Office to be cured by, Melkerson et al.), and that as a

result, there is no *prima facie* case of obviousness of claims 14-21 over Bohland et al. and Melkerson et al.

**CONCLUSION**

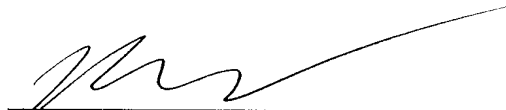
Applicant respectfully submits that the claim of this application, including newly added claims 22-27, are patentable over the cited references for the reasons given above. An early notification to this effect is respectfully requested. In the event that there are any questions concerning this Amendment, or the application in general, the Examiner is respectfully urged to telephone the undersigned to arrange for a personal or telephonic interview to resolve these issues prior to the issuance of another Office action.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

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By:



Bruce D. Gray  
Registration No. 35799

P.O. Box 1404  
Alexandria, VA 22313-1404  
703 836 6620

**Marked Up Copy  
Substitute Specification**

A METHOD OF RECYCLING AN EXHAUSTED SELENIUM FILTER MASS

BACKGROUND

1. Field

~~This invention relates to~~ Disclosed herein is a process for reclaiming spent selenium filter mass containing an inert material, following take-up of mercury by a substance which contains selenium and is present in the filter mass. Selenium is present in spent selenium filters, both in unspent active filter mass, mainly as elemental selenium, and in reacted filter mass as mercury selenides.

2. Description of Related Art

Selenium filters are being used for taking up gaseous elemental mercury, normally in small amounts, from gases and contain a filter mass consisting of an active substance of elemental selenium, selenium sulphide or some other active selenium compound which is capable of reacting with elemental mercury. The main portion of the filter mass consists of a carrier of an inert material, which may consist of silica, aluminium oxide, or a ceramic material. Such a filter, which has been in general use for various purposes for about thirty years, is disclosed in US 3 786 619 which also teaches a suitable method for making the filter.

In use of the filter, the active substance is gradually consumed, forming mercury selenide, and after operation over a period of time the performance of the filter will be reduced so much that its ability to take up mercury and perform the cleaning is no longer adequate. The filter mass is then replaced with fresh filter mass and the



spent filter mass must be deposited disposed of in a suitable manner. Such ~~deposition~~ disposal is costly in itself and also requires payment of waste tipping fees. In addition, the ~~deposition~~ disposal often causes problems for several other reasons, **[[i.a.]]** e.g., environmentally, and both the carrier material and the active substance are of considerable value. As indicated initially, the used filter mass contains some unspent selenium-containing active substance, while the remainder of the selenium content of the active substance has reacted with mercury to form mercury selenide, which is a very stable compound.

Typically, the spent filter mass may contain 1 to 5 % by weight of Hg and may still contain 3 to 5 % by weight of unspent elemental selenium.

This being so, a reprocessing method for reclaiming the active substance and/or the carrier material is highly desirable. It is also desirable to be able to separate mercury contained in the filter mass from the inert carrier so that the amount of material that has to be deposited disposed of is as small as possible, e.g. to reduce the costs for the ~~deposition~~ disposal.

Previously, methods have been proposed for processing mercury-containing waste at relatively high temperatures and in the presence of selenium to remove the mercury of the waste in the form of gaseous selenides. In such a method, primarily developed for used button-type batteries, which is described in EP 0655794, the batteries are treated in a rotary furnace at about 800°C in the presence of selenium to evaporate mercury in the form of selenide, thereby making the batteries harmless.

Such prior art methods for the destruction of mercury-containing materials are not useful or even feasible for processing spent selenium filter masses, particularly so if

the filter masses are to be reclaimed, because capture of mercury existing as elemental mercury,  $\text{Hg}^0$ , and as selenide,  $\text{HgSe}$ , will be problematic. Separation of the selenium for reclaiming will also be troublesome.

### SUMMARY

~~The object of the invention is to provide~~ Disclosed herein is a process by which spent selenium filter masses can be reprocessed, in a manner that is both economically and environmentally acceptable, for reclaiming both the selenium and the filter mass. With such a process, a spent selenium filter mass can be cleaned and reused, while, captured mercury contained in the filter mass can be separated and deposed disposed of in a suitable stable form.

To that end, the filter mass is treated in the steps which are set forth in the ~~accompanying-claims~~ herein. In the course of the reclaiming process, the used and spent selenium filter mass is first treated with a hydrogen peroxide solution, suitably having a concentration of about 50 %, for leaching out essentially all of the unspent active substance in the filter mass, which is obtained in the ~~[[to]]~~ form of selenious acid. The resulting selenious acid is then separated and isolated. Then, this selenious acid is advantageously transferred to an installation for producing new selenium filter mass.

The filter mass that has been freed from the solution is then treated with aqua regia, preferably at an elevated temperature, for dissolving essentially all of the mercury selenide contained in the mass. The remaining filter mass, which is mainly formed of the inert carrier, remains essentially undissolved. The aqua ~~regia~~ solution with the content of mercury dissolved in it and selenium from the dissolved mercury selenide are separated from the filter mass and isolated.

Suitably, the aqua regia solution is heated and aerated to evaporate any excess of aqua regia. If it is desired to reclaim selenium from the solution, SO<sub>2</sub> is introduced into the solution after a partial neutralisation by suitable pH adjustment, resulting in precipitation of selenium as elemental selenium, Se(s), that can be used to produce selenious acid for use, if desired, in the production of new filters. After further partial neutralisation of the solution, the mercury can be precipitated in the form of some poorly soluble compound other than selenide, such as sulphide. Thus, the solution can be reprocessed for reclaiming the selenium it contains, and the mercury content can also be obtained in a form that is suitable for ~~deposition~~ disposal in an environmentally safe manner. Such reprocessing is not always possible or desirable, however, and, after neutralisation, the mercury and the selenium contained in the solution will then be precipitated as HgSe, so that mercury is taken care of for ~~deposition~~ disposal in that very stable form. As indicated, it is preferred, however, to obtain the selenium for reuse and ~~depøse~~ dispose of the mercury in a different stable form, such as sulphide.

Being now essentially free from the aqua regia solution and only containing inert material, the filter mass is washed and dried and then, like the previously separated selenious acid, forwarded to production of new selenium filter mass.

#### BRIEF DESCRIPTION OF DRAWING

The invention will now be described as a preferred embodiment illustrated in the figure which is a diagrammatic flow chart of a process according to the invention.

#### DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

The selenium filter mass is first fed to a tank for "Leaching 1", in which the filter mass

is leached with about 50 % hydrogen peroxide,  $\text{H}_2\text{O}_2$ , for leaching out selenium, that is, the unspent content of selenium, not bound to mercury, of the active filter mass. This leaching, which can be carried out in several steps, results in formation of selenious acid,  $\text{H}_2\text{SeO}_3$ , which can be used as a starting material in the production of a selenium filter mass as is disclosed in the previously mentioned US 3 786 619. A solution containing selenious acid is thus obtained and forwarded to a purifying and filtering unit from which pure selenious acid is further transferred to an installation for the production of selenium filter masses.

The leach residue from "Leaching 1", that is, the remaining filter mass with its content of mercury selenide, is then subjected to another leaching step in "Leaching 2". In this leaching, which is carried out with aqua regia, that is, concentrated nitric acid mixed with three times as much of concentrated hydrochloric acid, the solid mercury selenide will be dissolved while forming a solution containing selenium and mercury in ionic form. Optionally, the leach tank may be heated so that the leaching takes place at an elevated temperature. The leaching is carried on until all or at least almost all of the mercury selenide content has been dissolved.

The solution with its dissolved content of mercury and selenium is separated from the leach residue, which is essentially formed by the inert carrier of the mass. The leach residue is withdrawn and washed with water and dried so that a suitable carrier raw material for the production of filter masses is obtained, whereupon it is forwarded to an installation for such production.

The solution of aqua regia from "Leaching 2" is heated and blown with air for removing excess aqua regia, whereupon the solution is partially neutralised in two steps so that the selenium can first be precipitated with  $\text{SO}_2$  while forming  $\text{Se(s)}$ ,

whereupon the precipitate of elemental selenium is separated from the solution.

Using sodium sulphide or a different sulphide, ~~selenium~~ mercury is then precipitated as HgS which can be separated and withdrawn for ~~deposition~~ disposal.

After suitable purification, the precipitate of elemental selenium, Se(s), from the neutralisation step can be brought to the installation for filter production.

~~The inventive step of the invention will now also be elucidated~~ specific embodiments of the process described herein will now be described in more detail, and in particular from an environmental and economical point of view, and with reference to a non-limiting example.

It can be estimated that a spent filter mass contains at most 125 kg of mercury per cubic metre. When transformed to HgS of a density of 8100 kg/m<sup>3</sup>, a volume of about 18 litres of fine-grained sludge is obtained. Even if small amounts of other substances should accompany the precipitate, the volume will not exceed 50 litres. That is, the volume of mercury-containing waste to be ~~deposed~~ disposed of will only be about 5 % of the original volume. Thus, the need for ~~deposition~~ disposal is reduced to one twentieth when spent selenium filters are reprocessed in accordance with the invention. If the selenium of the mercury selenides formed is reclaimed, there are basically no selenium wastes and attendant losses.

The cost reduction obtained by the process according to the invention is substantial. A direct conversion based on the volume would thus result in a reduction of the ~~deposition~~ disposal cost by as much as 95 %. The reuse of the cleaned carrier mass also means a great cost reduction.

#### Example

In preliminary tests, leaching of the filter mass was carried out with an initial Hg content of 2.72 % and an initial Se content of 5.5 %. Leaching 1 using hydrogen peroxide resulted in leaching out of a total of 72 % of the selenium contained in the filter mass. In a following Leaching 2 using aqua regia, 99 % of the mercury content and also 25 % of the original selenium content could be leached out. The solution was neutralised, and selenium and mercury were precipitated as sulphides. After the precipitation the solution contained <0.001 % of the original content of mercury and 2.5 % of the original content of selenium. After washing of the leached mass, the mass contained only 0.2 % Hg of the original content, corresponding to a mercury content in the fully leached mass of about 0.005 %. These tests thus show that it is possible selectively to leach out the selenium which can then be returned to production of selenium filter masses. The leaching out of mercury has also been found to be effective, and the process according to the invention has reduced the volume to be deposited disposed of as mercury sulphide to about one eightieth of the original volume.

The invention having been described herein by reference to certain specific embodiments, it will be understood that such description and embodiments are not limiting of the appended claims.